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Narrow-band f.m. systems for television links: u.h.f. Band V frequency availability

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NARROW-BAND F.M. SYSTEMS FOR TELEVISION LINKS: UHF BAND V FREQUENCY AVAILABILITY

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Summary

Frequency-modulated television links operating in the u.h.f. broadcast Band V are used for remote and mobile cameras at outside broadcast sites. The expansion of the u.h.f. network has made it difficult to find frequencies for use at some locations.

This investigation continues the series of Research Department investigations on narrow-band f.m. systems with assessments of mutual interference between the links and the projected u.h.f. network for vestigial and double side-band systems at six typical OB sites. It is concluded that there would be no significant difference between the systems in terms of channel availability either before or after the introduction of the fourth television network on u.h.f.

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1. Introduction

Frequency-modulated television links operating in Band V are used for remote and mobile cameras at outside-broadcast sites such as horse racing and golf courses. The use of this band is permitted on a 'non-interference to broadcasting' basis.

The expansion of the u.h.f. broadcast network has made it difficult to find frequencies for use at some outside broadcast locations, which are free of interference both to the link from television transmitters, and from the link to domestic receivers.

At present these links use double-side-band (d.s.b.) equipment, normally with a maximum deviation of 4 MHz peak-to-peak, operating in a 16 MHz bandwidth. A feasibility study[1] has shown that it would be possible to restrict the bandwidth of the links to 8 MHz by employing vestigial side-band (v.s.b.) techniques.

Earlier work[2] investigated the interference levels between f.m. and a.m. television signals for both full-bandwidth (d.s.b.) and restricted-bandwidth (v.s.b.) systems. This work also established optimum carrier rest positions.

This report concludes this series of investigations on narrow band f.m. systems by comparing the frequency availability in the u.h.f. broadcast Band V for d.s.b., with that for the v.s.b. system. This will ascertain if there is any practical advantage of v.s.b. over d.s.b.

Frequency availability is determined by the ability to keep mutual interference between the OB links and broadcast services within acceptable limits. Mutual interference levels have therefore been examined for d.s.b. and v.s.b. at six sites regularly used for television O.B.'s.

Previous work[2] had established that the v.s.b. system should use 4 MHz peak-to-peak deviation, with the upper side-band suppressed and a carrier rest position on the upper edge of a broadcast channel designated N. The d.s.b. system examined also employs a 4 MHz peak-to-peak deviation with the carrier rest position on the upper edge of channel N.

Fig. 1 - Sites investigated

The six sites, shown in Fig. 1, cover a wide area and are located at Aintree, Ascot, Ayr, Chepstow, Doncaster and Newbury.

2. Calculation of interference

2.1. General

Interference calculations were based on the planning standards, for aerial directivity, etc. which are used for planning the u.h.f. television network within the UK. Field strength calculations used the BBC Research Department computer programme incorporating a terrain data bank and were carried out for each channel 39 to 67; the use of channel 68 is precluded because of the out-of-band radiation which would occur. No distinc-

tion was made between existing and planned stations; however, the fourth programme (P4) has been considered separately because it may still be several years before transmissions start. Calculations have been made for link transmissions with both horizontal and vertical polarization.

The protected field strength gives the signal level which must be provided by the wanted transmitter to overcome the interference from an unwanted source. It is the sum of the field strength of the interfering source, the receiving aerial discrimination and the protection ratio, all expressed in decibels. Only non-fading interference has been considered and hence, all interference levels have been calculated for 50% time using the protection ratios of just perceptible interference.

2.2. Calculations of interference to System I television reception

Calculations of interference to domestic television reception were made at locations within the service areas of those Band V transmitters near to the outside broadcast site. The link transmitters have a transmitter power of 1 watt with an aerial gain of 7 dB giving an effective radiated power of 5 watts.

The protection ratios derived from earlier work[2] for just perceptible interference are shown in Table 1. f_v is the vision carrier of the a.m. television transmission and f the carrier rest frequency of the link transmission which is on the upper edge of channel N.

TABLE 1

Protection ratios for just perceptible interference from f.m. links to System I television

Channel	$(f_v - f)$, MHz	Protection ratios, dB	
		d.s.b.	v.s.b.
N − 1	−14·75	4	4
N	− 6·75	44	44
N + 1	+ 1·25	43	40
N + 2	+ 9·25	10	2

The protected field strength must be less than the marginal limit of service, namely 64 dB(μV/m), for interference to the domestic service to be acceptable.

2.3. Calculation of interference to f.m. link reception

Interference calculations have been made to the f.m. link sites, from any existing or planned television stations from which it is possible that significant interference could occur. The protection ratios for just perceptible interference are shown in Table 2.

TABLE 2

Protection ratios for just perceptible interference from System I television to f.m. links

Channel	$(f_v - f)$, MHz	Protection ratios, dB	
		d.s.b.	v.s.b.
N − 2	−22·75	−10	−18
N − 1	−14·75	0	− 1
N	− 6·75	29	33
N + 1	+ 1·25	33	35
N + 2	+ 9·25	− 3	−12

In assessing interference to the links, for this exercise the use of an omni-directional receiving aerial is assumed, because at most sites it would be an operational requirement for reception of remote cameras from all directions. A discrimination of 15 dB is, however, allowed against orthogonally-polarized interference.

If the protected field strength is less than 75 dB(μV/m) then the frequency is considered to be available. If the protected field strength is between 75 and 85 dB(μV/m) the frequency is considered to be available if care is taken with the siting of the receiving aerial.

It is known that the link equipment will operate at field strengths below 75 dB(μV/m) but this figure has been chosen because it is considered to be the operating level which would be achieved at most sites. A lower value would further have restricted the use of both v.s.b. and d.s.b. links because of interference from television. It would have been possible to give a protected field strength for operation of the link at each site and give a statistical analysis comparing v.s.b. with d.s.b. at all sites and frequencies. This, however, would have been an unnecessary complication which would not have reflected the basic operational need, namely, the availability of one or two frequencies at all sites.

TABLE 3

Frequencies available before the introduction of P4

Broad-cast channel	Freq. MHz	Polari-zation	Aintree		Ascot		Ayr		Chepstow		Doncaster		Newbury	
			d.s.b.	v.s.b.	d.s.b.	v.s.b.	d.s.b.	v.s.b.	d.s.b.	v.s.b.	d.s.b.	v.s.b.	d.s.b.	v.s.b.
39	622	HP VP	B A	B A							B A	B A		
40	630	HP VP	A A	B A							A A	A A		
41	638	HP VP	A A	A A			A A	A A			A A	A A		
42	646	HP VP	B A	B A										
43	654	HP VP												
44	662	HP VP					A A	A A						
45	670	HP VP												
46	678	HP VP												
47	686	HP VP	B		B	A	A A	A A	B A	B A			A	A A
48	694	HP VP					A A	A A	B A	B A			A A	A A
49	702	HP VP					A A	A A					A A	A A
50	710	HP VP					A A	A A					A A	A A
51	718	HP VP					A A	A A					A A	A A
52	726	HP VP					A A	A A					A A	A A
53	734	HP VP			B A	A A	A A	A A			B	A A	A A	A A
54	742	HP VP					A A	A A	A A	A A	A A	A A	A A	B A
55	750	HP VP					A A	A A	A A	A A	A A	A A	A A	A A
56	758	HP VP					B	B			A A	A A		
57	766	HP VP					A	B						
58	774	HP VP											B A	A
59	782	HP VP					B	B			A A	A A		
60	790	HP VP					A	B						
61	798	HP VP											B A	A
62	806	HP VP					B	B			A A	A A		
63	814	HP VP					A	B						
64	822	HP VP	B	B									B A	A
65	830	HP VP	A A	A A	B A	A A	A A	A A			A A	A A	A A	A A
66	838	HP VP	A B	A A	A	A	A A	A A	A	A A	A A	A A	A A	A A
67	846	HP VP	A B	A A	A	A	A A	A A	A A	A A	A A	A A	A A	A A

TABLE 4

Frequencies available after the introduction of P4

Broad-cast channel	Freq. MHz	Polari-zation	Aintree		Ascot		Ayr		Chepstow		Doncaster		Newbury	
			d.s.b.	v.s.b.	d.s.b.	v.s.b.	d.s.b.	v.s.b.	d.s.b.	v.s.b.	d.s.b.	v.s.b.	d.s.b.	v.s.b.
39	622	HP VP	B A	B A										
40	630	HP VP												
41	638	HP VP					A A	A A						
42	646	HP VP												
43	654	HP VP												
44	662	HP VP					A A	A A						
45	670	HP VP												
46	678	HP VP												
47	686	HP VP	B				A A	A A					A	A A
48	694	HP VP					A A	A A					A A	A A
49	702	HP VP											A A	A A
50	710	HP VP											A A	A A
51	718	HP VP					A A	A A					A A	A A
52	726	HP VP					B	B						
53	734	HP VP					A	B						
54	742	HP VP											A	A
55	750	HP VP					A A	A A			A A	A A	A A	A A
56	758	HP VP					B	B			A A	A A		
57	766	HP VP					A	B						
58	774	HP VP											A	A
59	782	HP VP					B	B			A A	A A		
60	790	HP VP					A	B						
61	798	HP VP											B A	A
62	806	HP VP					B	B			A A	A A		
63	814	HP VP					A	B						
64	822	HP VP												
65	830	HP VP					A A	A A			A A	A A		
66	838	HP VP					A A	A A	A	A A	A A	A A		
67	846	HP VP					A A	A A	A A	A A	A A	A A		

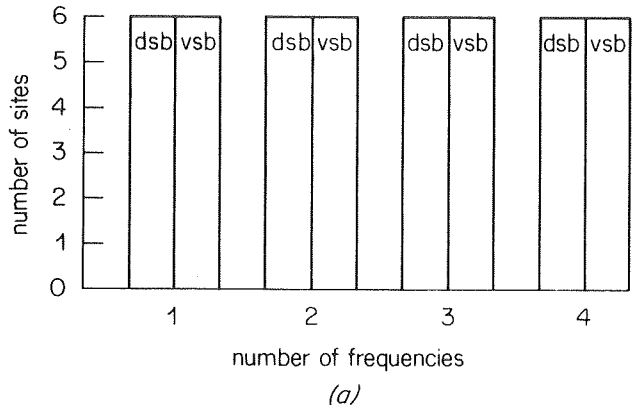
TABLE 5

	Protected field strength for interference from the link to domestic television reception dB(μV/m)	Protected field strength for interference from television transmissions to the link dB(μV/m)
A	$\leqslant 64$	$\leqslant 75$
B	$\leqslant 64$	75 – 85

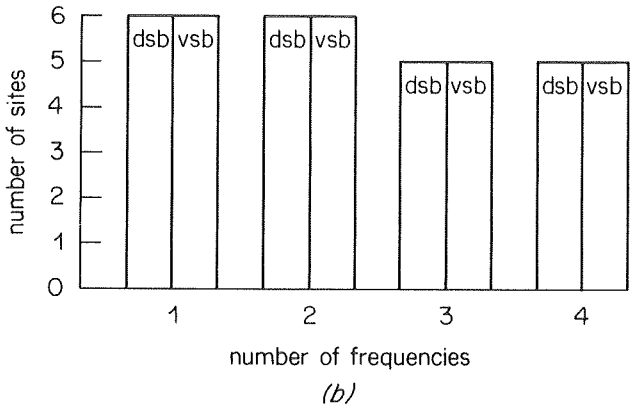
3. Frequency availability

The results of this study are shown in Table 3 for frequency availability before the introduction of the fourth channel television service, P4, and in Table 4 after P4's introduction. The available frequencies and polarizations for each site are indicated by the letters A and B. The significance of these letters is shown in Table 5.

Circular polarization, which is preferred for mobile use, can be used if a frequency is shown to be available for use for both horizontal and vertical polarization.



(a)

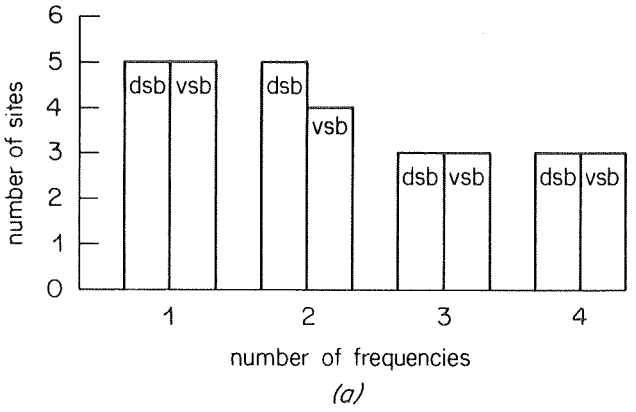


(b)

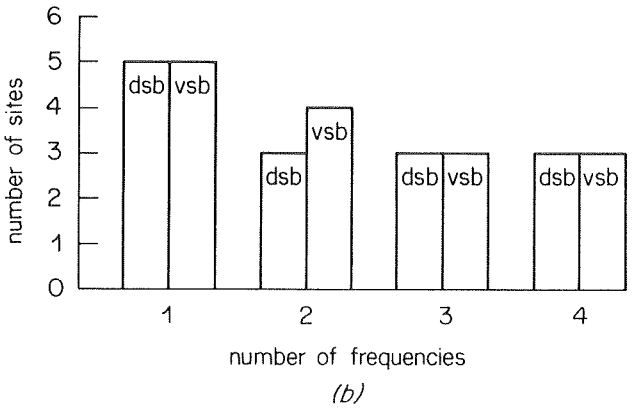
Fig. 2 - Frequencies available before the introduction of P4

(a) At least one polarization, either VP or HP, usable

(b) Both VP and HP (hence CP) usable



(a)



(b)

Fig. 3 - Frequencies available after the introduction of P4

(a) At least one polarization, either VP or HP usable

(b) Both VP and HP (hence CP) usable

These results are summarized by the histograms in Figs. 2 and 3 which relate frequency availability to number of sites; Figs. 2 and 3 show the position before and after the introduction of P4. Figs. 2(*a*) and 3(*a*) show the number of sites at which at least one polarization either horizontal (HP) or vertical (VP) is available and Figs. 2(*b*) and 3(*b*) show where HP and VP, and hence circular polarization (CP), can be used.

Even though it is not normally required to have more than one or two frequencies available at a site the histograms show the situation for up to

four frequencies available to indicate the margins which exist for each system.

These figures show that there are no significant differences in frequency availability between v.s.b. and d.s.b. either before or after the introduction of P4 for either VP, HP or CP.

4. Conclusions

This study has examined the frequency availability within the u.h.f. Band V for two f.m. television link systems. It has indicated that even though the adjacent-channel performance of the v.s.b. system is superior to that of a d.s.b. system, in practice because of the allocation of the broadcast channels within the UK the advantage does not result in increased frequency availability.

The extra expense that a v.s.b. system would entail could therefore not be justified on the grounds that an increased number of sites could continue to use Band V for television links after the introduction of P4.

It should also be noted that because the restrictions on use are as often due to interference to broadcast reception as from it, the use of a system with a v.s.b. receiver and a d.s.b. transmitter would not be justified either.

Since there is no advantage in using v.s.b., it is recommended that future equipment for operation in the u.h.f. broadcast Band V should operate with the full-bandwidth, using a maximum deviation of 4 MHz peak-to-peak, since d.s.b. equipment will have lower cost than v.s.b. equipment. The carrier rest position should be at the upper edge of the relevant broadcast channel.

5. References

1. STOREY, R. Narrow-band f.m. system for television links: a feasibility study. BBC Research Department Report No. 1978/20.

2. GILCHRIST, N.H.C. *and* LYNER, A.G. Narrow-band f.m. system of television links: interference between f.m. and a.m. television signals. BBC Research Department Report No. 1978/21.

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